JPSS Vegetation Index & Green Vegetation Fraction Products

Yunyue Yu
NOAA/NESDIS/STAR
Yunyue.Yu@noaa.gov

Mingshi Chen, Feng Zhao, Yuxiang He, Zhangyan Jiang
IMSG/STAR

Tomoaki Miura
Univ of Hawaii

Outline

- ❑ Cal/Val Team Members
- ❑ VIIRS NVPS* Production Overview
  - NDE VI & GVF Algorithm
  - Performance Overview
  - NOAA-20 VI Product Status
  - Long Term Monitoring
- ❑ A concern on input data consistency
- ❑ Interactive communication with users
- ❑ Summary and Path Forward

**NVPS = NDE Vegetation Product System*

Cal/Val Team Members

	Name	Organization	Major Task
STAR/ EMB	Ivan Csiszar	NOAA/NESDIS/STAR	Land Lead
	Yunyue Yu	NOAA/NESDIS/STAR	EDR Lead, algorithm development/improvement, calibration/validation, team management
	Feng Zhao	NOAA Affiliate, IMSG	Product validation and assessment,
	Mingshi Chen	NOAA Affiliate, IMSG	Algorithm development/improvement, product monitoring
	Zhangyan Jiang	NOAA Affiliate, IMSG	Algorithm development/improvement, product monitoring
	Yuxiang He	NOAA Affiliate, IMSG	Product visualization, monitoring
STAR/ OPDB	Walter Wolf	NOAA/NESDIS/STAR	STAR ASSIST Lead
	Valerie Mikles	NOAA Affiliate, IMSG	STAR ASSIST, Algorithm System integration
	Michael Wilson	NOAA Affiliate, IMSG	STAR ASSIST, Algorithm System integration
U. Hawaii	Tomoaki Miura	U. Hawaii	Scientific support on validation and improvement

Overview -- VI

- VIIRS VIs are inherited products from **MODIS VI** and **AVHRR VI**
- VIIRS VIs consists of TOA NDVI, TOC NDVI and TOC EVI

$$NDVI^{TOA} = \frac{\rho_{I2}^{TOA} - \rho_{I1}^{TOA}}{\rho_{I2}^{TOA} + \rho_{I1}^{TOA}}$$

$$NDVI^{TOC} = \frac{\rho_{I2}^{TOC} - \rho_{I1}^{TOC}}{\rho_{I2}^{TOC} + \rho_{I1}^{TOC}}$$

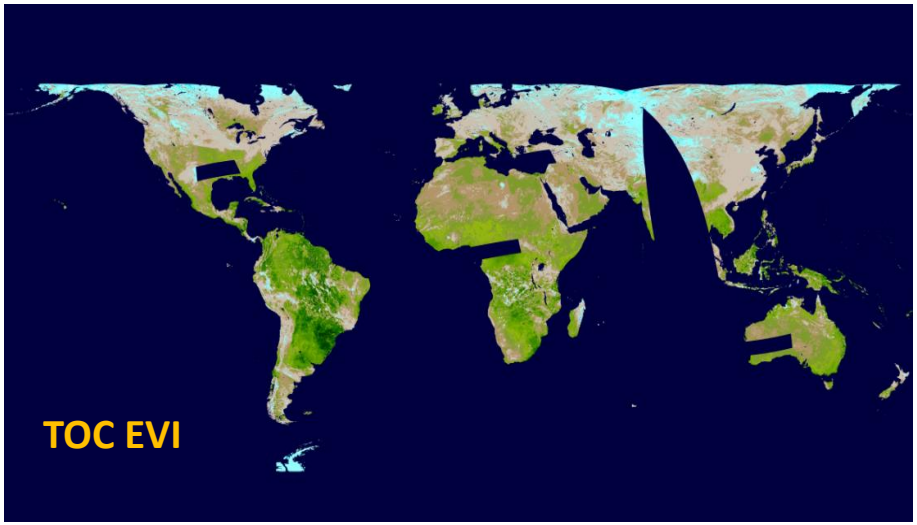
$$EVI = (1 + L).\frac{\rho_{I2}^{TOC} - \rho_{I1}^{TOC}}{\rho_{I2}^{TOC} + C1.\,\rho_{I1}^{TOC} - C2\,.\,\rho_{M3}^{TOC} + L}$$

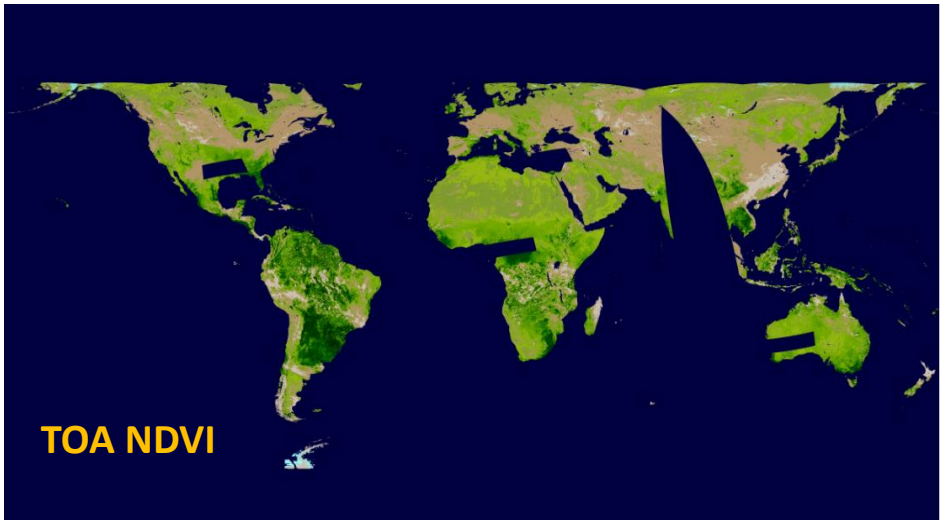
- Coverage: Daily, weekly and biweekly at global (4 km) and regional level (North America,1 km)

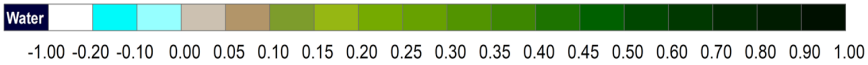
NDE VI algorithm output

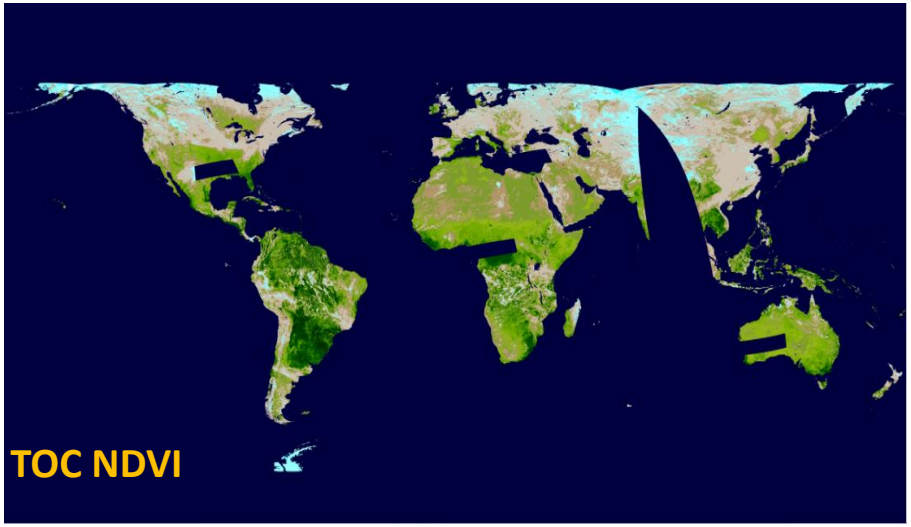
Temporal Scale	Spatial Scale	Format	File Name (samples)
Daily (DLY)	Global (4km)	netCDF4 (*.nc)	VI-DLY-GLB_v1r2_npp_s20171226_e20180110_c201803161653550.nc
	Regional (1km)		VI-DLYL-REG_v1r2_npp_s20171226_e20180110_c201803161740430.nc
Weekly (WKL) 7-day	Global (4km)		VI-WKL-GLB_v1r2_npp_s20171226_e20180110_c201803161653550.nc
	Regional (1km)		VI-WKL-REG_v1r2_npp_s20171226_e20180110_c201803161740430.nc
BiWeekly (BWKL) 16-day	Global (4km)		VI-BWKL-GLB_v1r2_npp_s20171226_e20180110_c201803161653550.nc
	Regional (1km)		VI-BWKL-REG_v1r2_npp_s20171226_e20180110_c201803161740430.nc

Overview -- VI



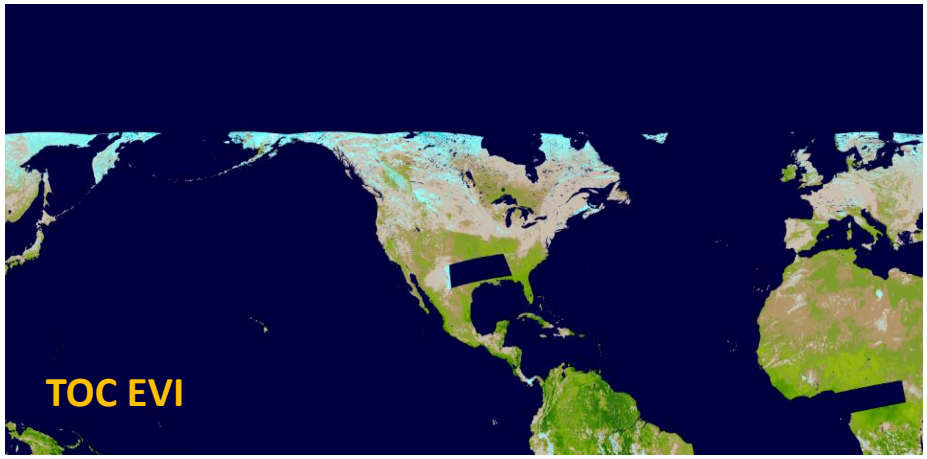


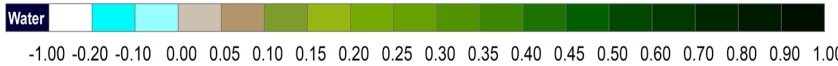


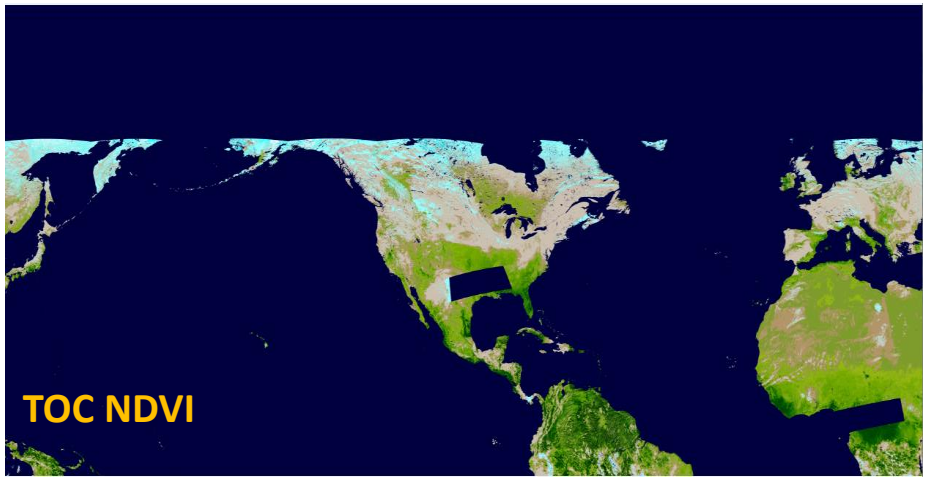


NDE *Global Daily* VIs on 01/04/2018

Overview -- VI







NDE *Regional Daily* VIs on 01/04/2018

Overview -- GVF

- Green Vegetation Fraction (GVF) is defined as fraction of a pixel covered by green vegetation if it were viewed vertically
- GVF EDR provides continuity with NOAA 16-km weekly AVHRR GVF
- GVF estimation is based on the Enhanced Vegetation Index (EVI)

$$GVF = \frac{EVI - EVI_0}{EVI_M - EVI_0}$$

Where EVI_0 and EVI_M , the global minimum and maximum EVI, are algorithm parameters determined experimentally, and need to be calibrated.

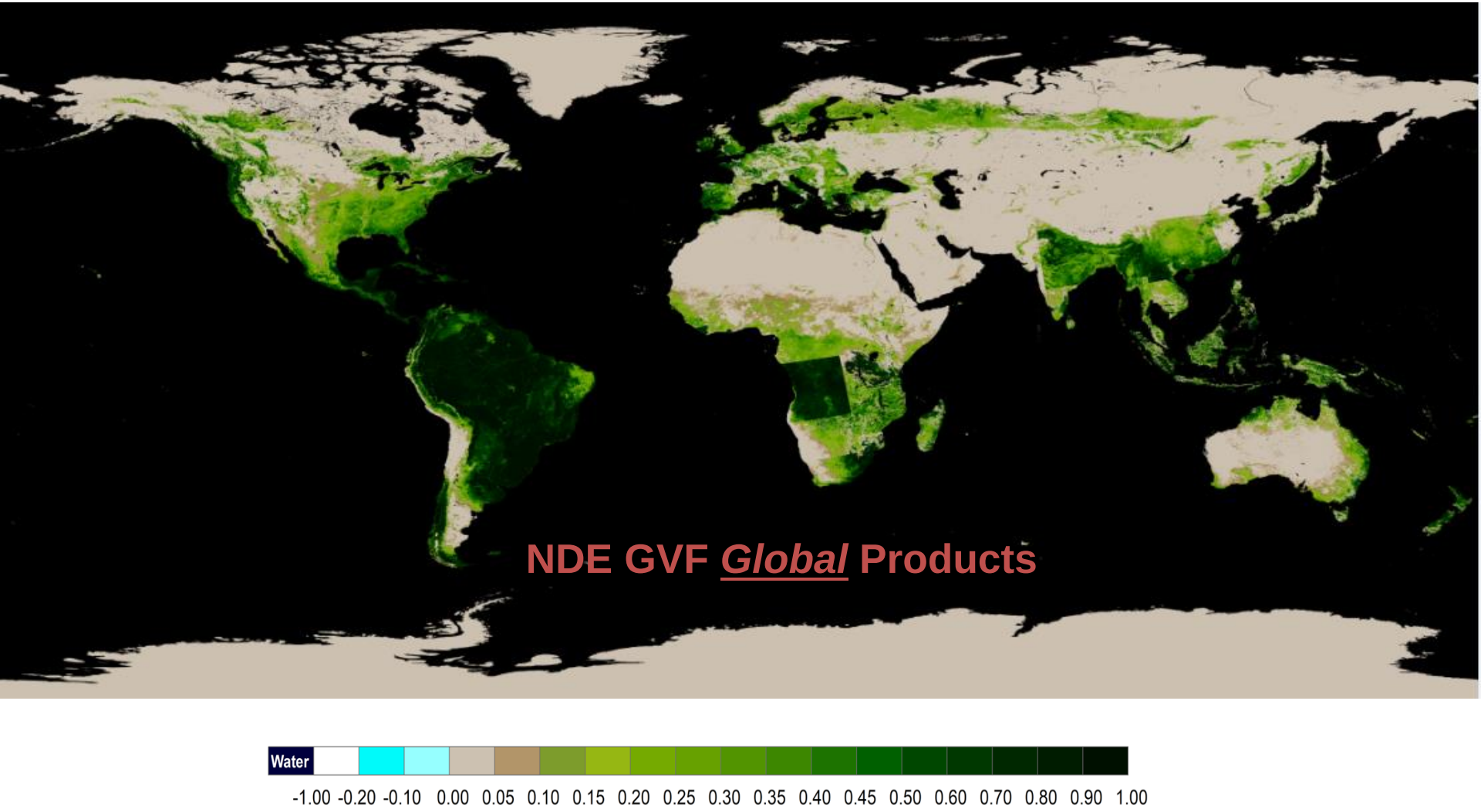
- Coverage: weekly at global (4 km) and regional level (North America,1 km)

NDE GVF algorithm output

Temporal Scale	Spatial Scale	Format	File Name (samples)
Weekly (WKL) 7-day	Global (4km) (GLB)	netCDF4 (*.nc)	GVF-WKL-GLB_v2r1_npp_ s20180103_e20180109_c201803191655370.nc
	Regional (1km) (REG)		GVF-WKL-REG_v2r1_npp_ s20180103_e20180109_c201803191657490.nc

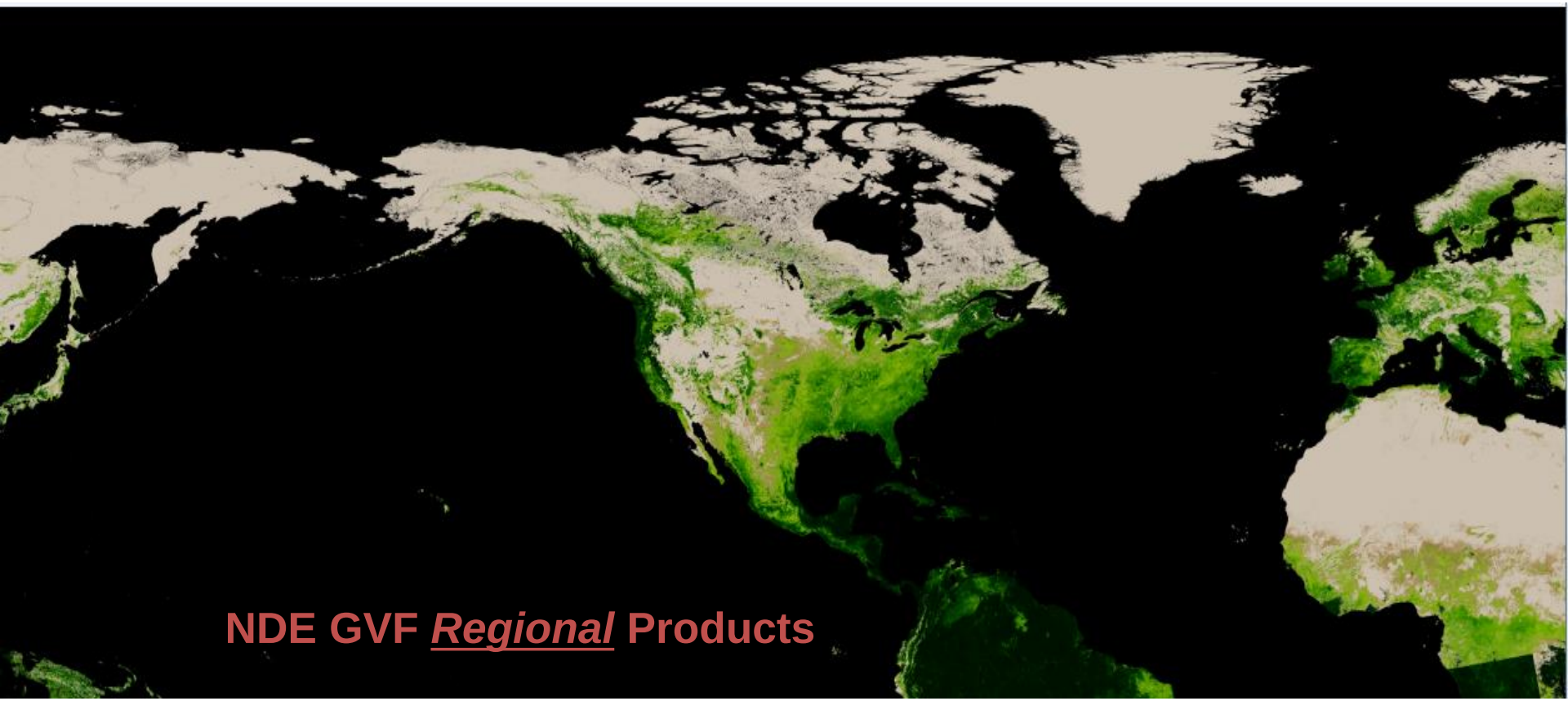
Overview -- GVF

GVF on 01/03/2018 ~ 01/09/2018

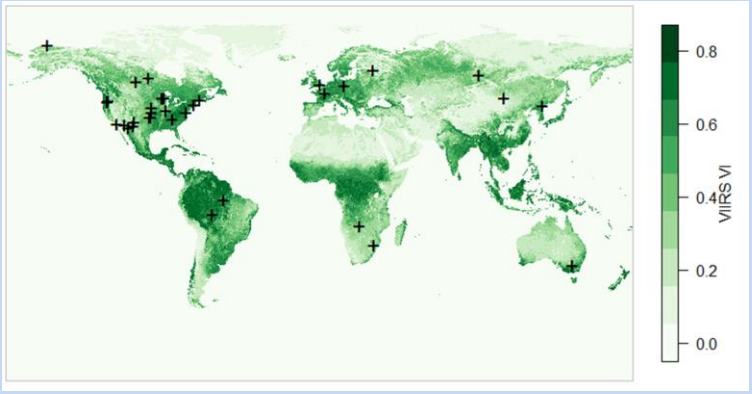


Overview -- GVF

GVF on 01/03/2018 ~ 01/09/2018

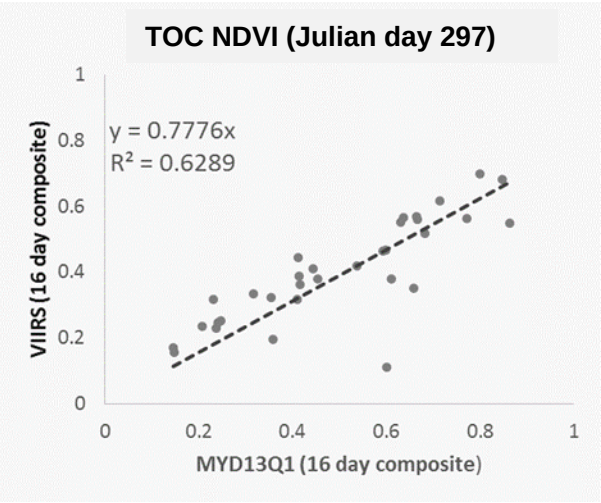


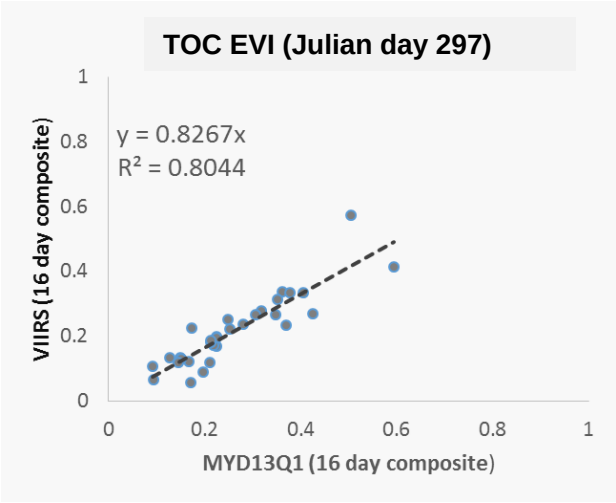
Product Performance Overview - VIs

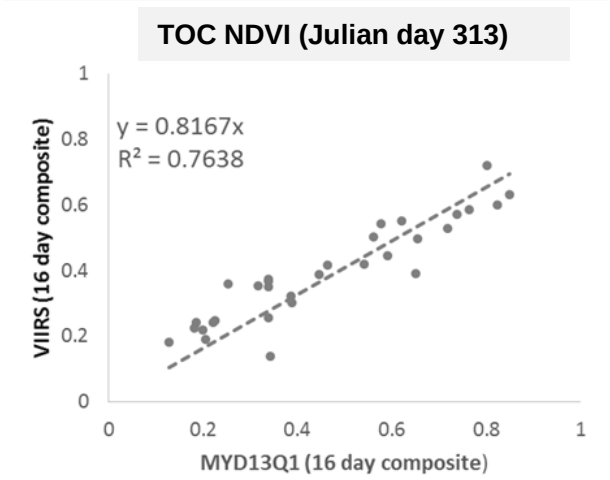


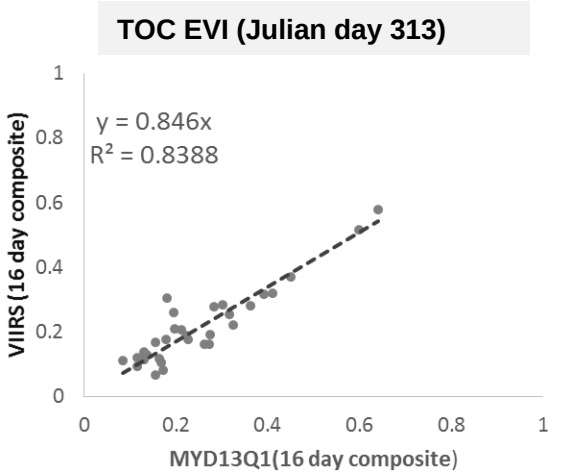
VI Product	Accuracy
NDVI TOC	-0.04
EVI TOC	-0.02

35 Flux Tower sites (EOS Land Validation Core Sites)





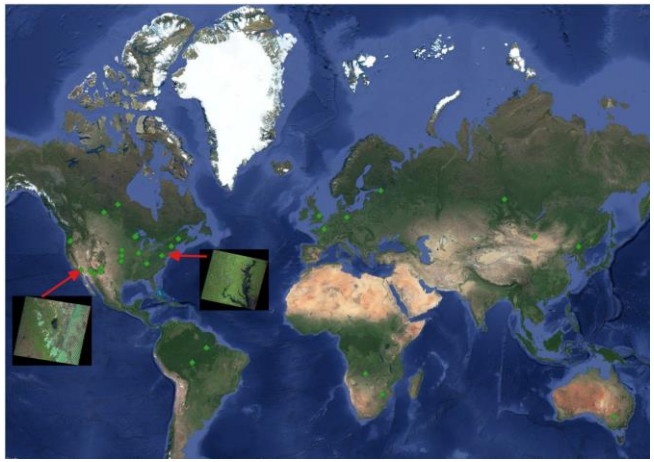




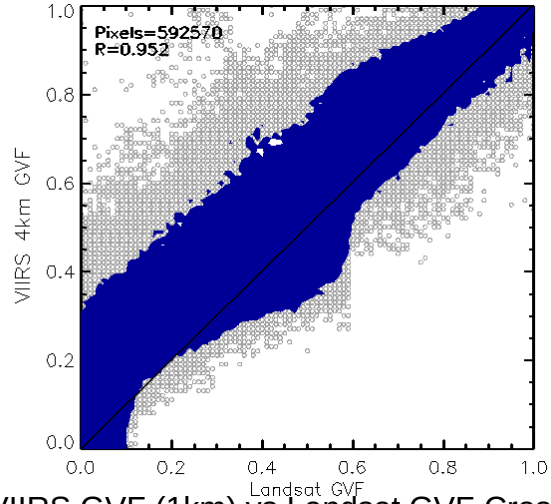
Product Performance Overview - GVF

VIIRS GVF vs. Landsat Derived GVF

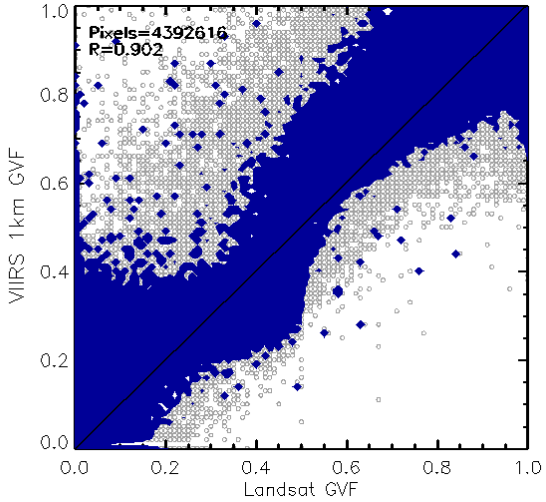
EOS Land Validation Core Sites



VIIRS GVF (4km) vs Landsat GVF Cross-plots



VIIRS GVF (1km) vs Landsat GVF Cross-plots



Global APU Estimates

Attribute	Threshold	Observed/validated
Measurement Accuracy		
1) Global	0.12	0.080
2) Regional	0.12	0.071
Measurement Precision		
1) Global	0.15	0.084
2) Regional	0.15	0.070
Measurement Uncertainty		
1) Global	0.17	0.116
2) Regional	0.17	0.100

Product Performance Overview - GVF

VIIRS GVF vs. Google Earth Derived GVF

Sample site (Park Falls, WI, USA)

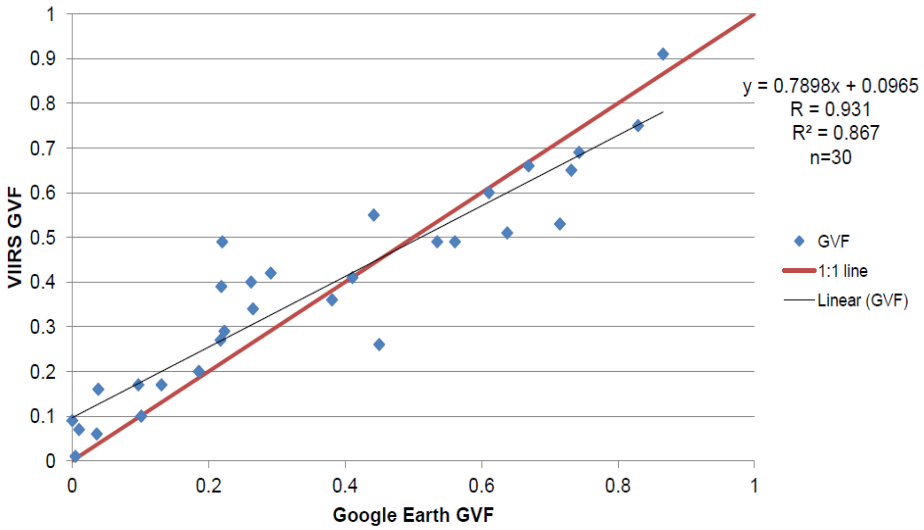
Google Earth image over a 0.036°x0.036° VIIRS GVF pixel

Classified image (vegetated pixels: bright green)

(5/10/2013)

Google Earth GVF=0.38
VIIRS GVF=0.36

VIIRS GVF (4km) vs Google Earth GVF – Scatterplot



APU Summary Table

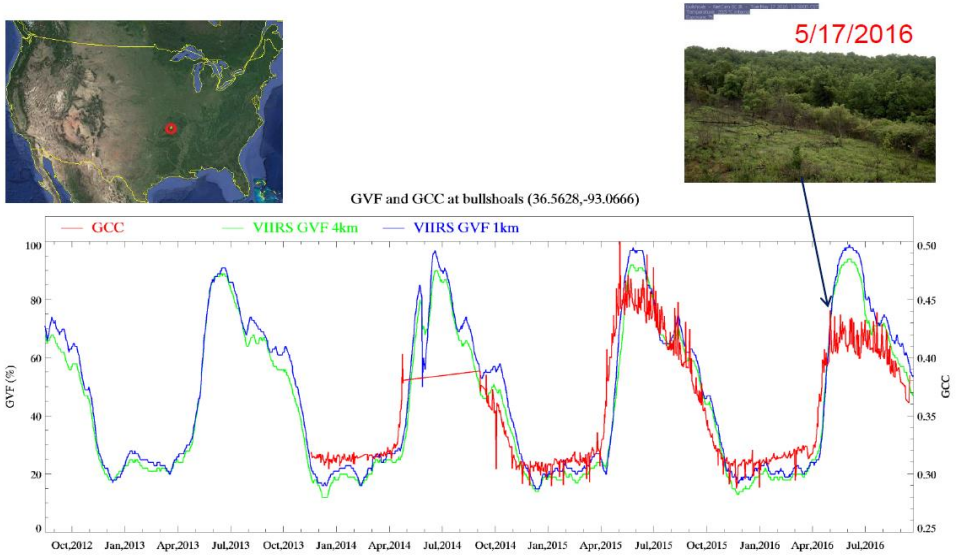
Attribute	Threshold	Calculated
Accuracy	0.12	0.0202
Precision	0.15	0.1010
Uncertainty	0.17	0.1014

Product Performance Overview - GVF

VIIRS GVF vs. PhenoCam GVF

PhenoCam images collected every half hour

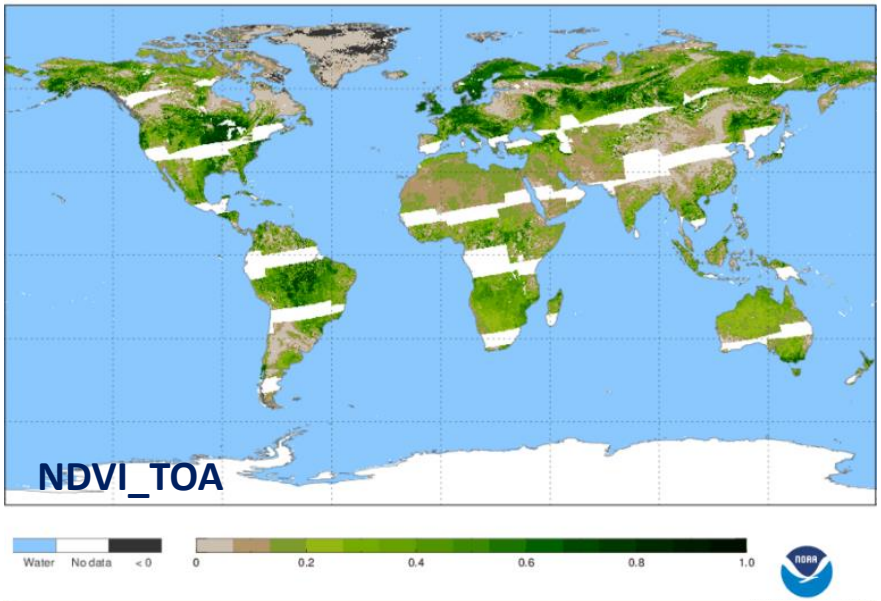
Sample site (Bull Shoals, Mo, USA)

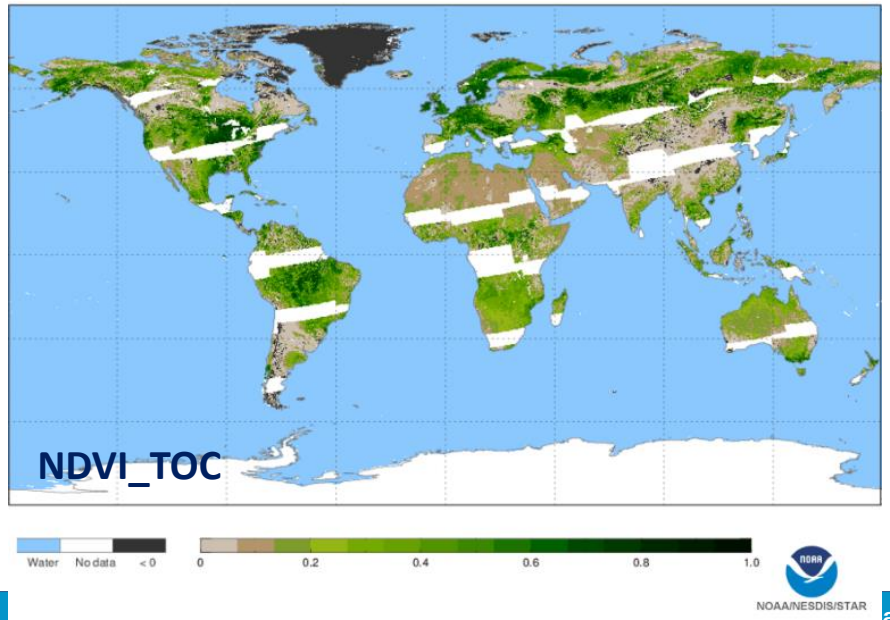


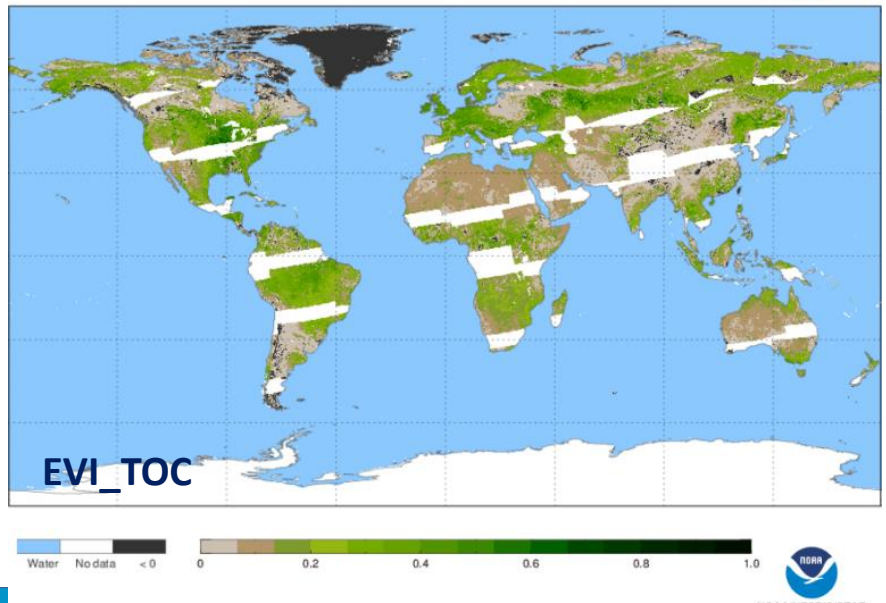
NDE NOAA-20 Status - VI

- The NDE SNPP algorithms are applied for NOAA-20 VI & GVF production (NDE)
- Beta maturity Review was done on Aug. 22., 2018
- Calibration and validation is on the way for Provisional maturity (Feb 2019)

NDE NOAA-20 VI *Global* Products 07/02/2018

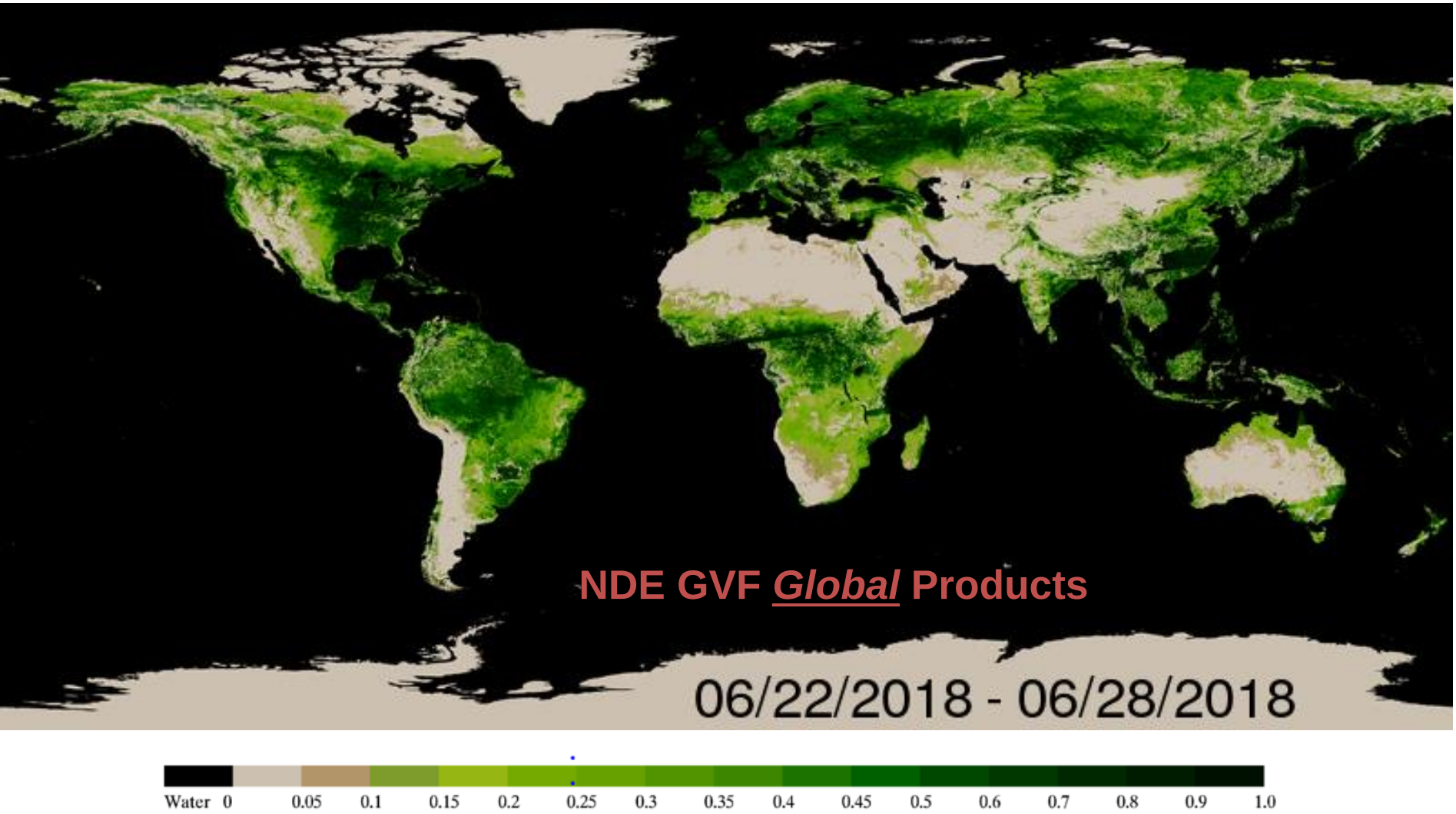




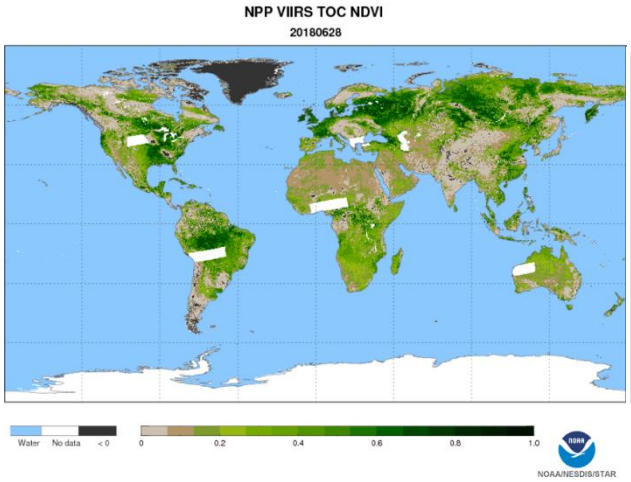


NDE NOAA-20 Status - GVF

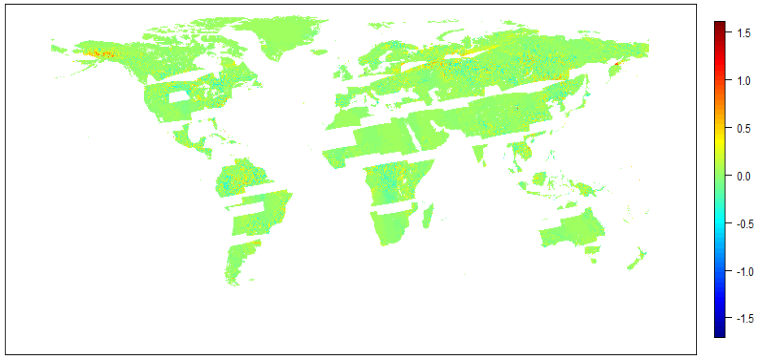
Jun 28, 2018 – July 20, 2018



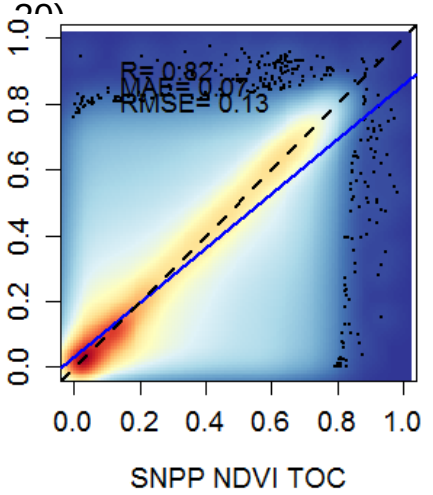
TOC NDVI Cross-comparison: NOAA-20 VS. SNPP

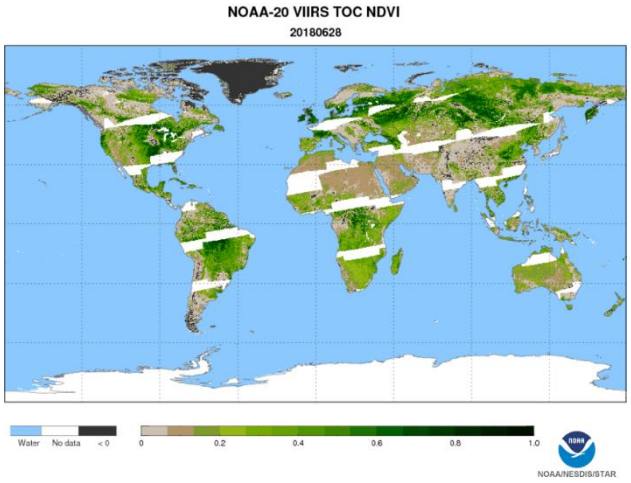


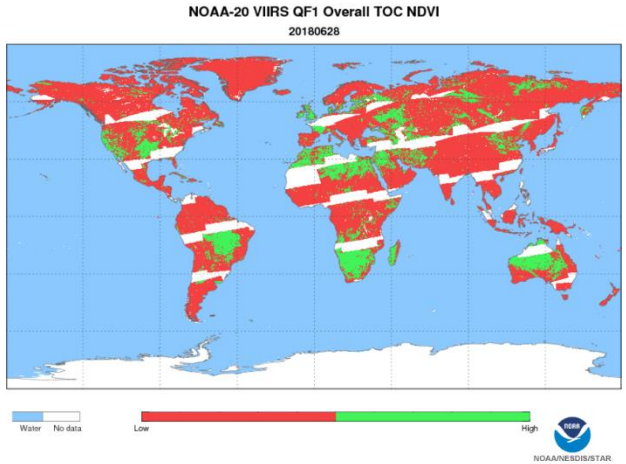
SNPP-NOAA-20

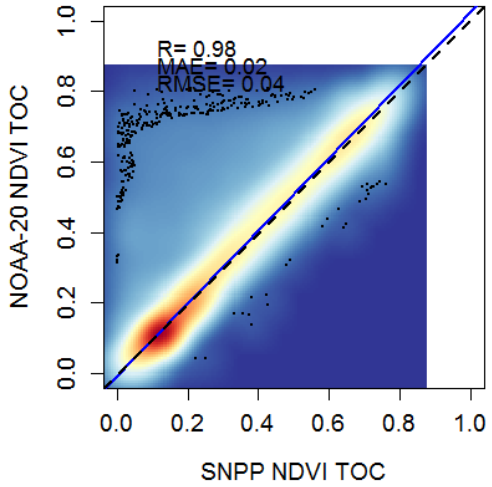


Scatterplot(SNPP-NOAA-20)

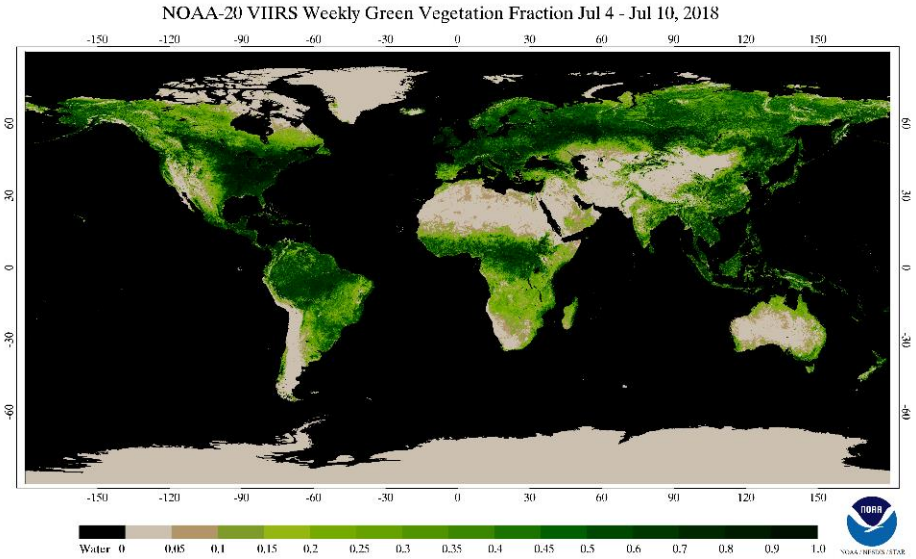


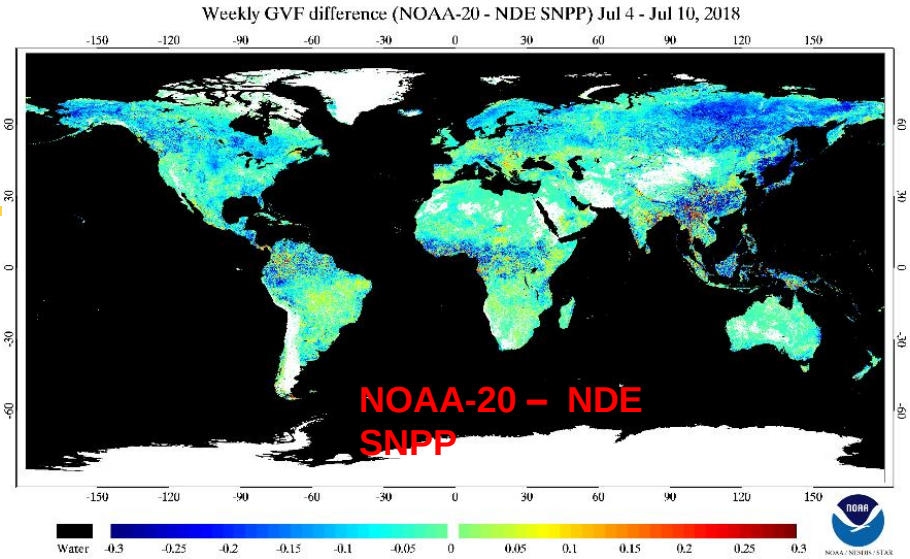


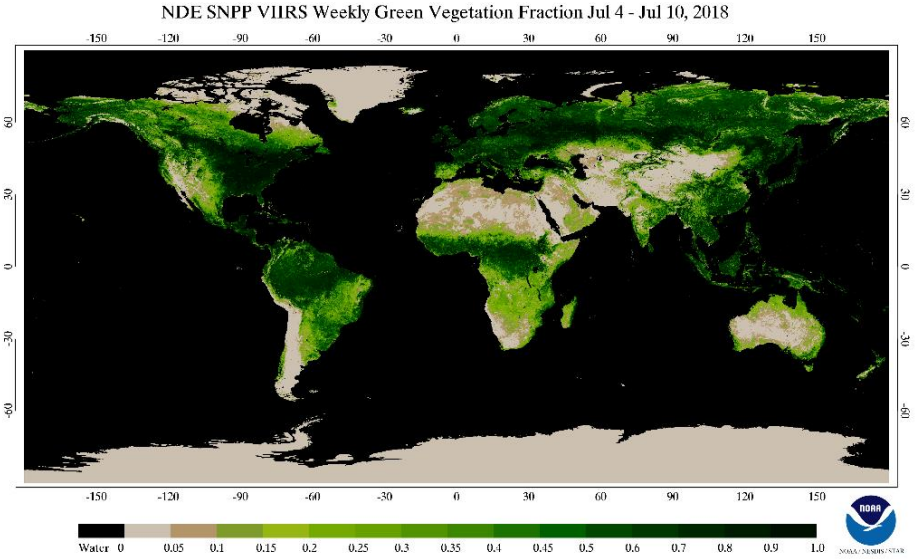


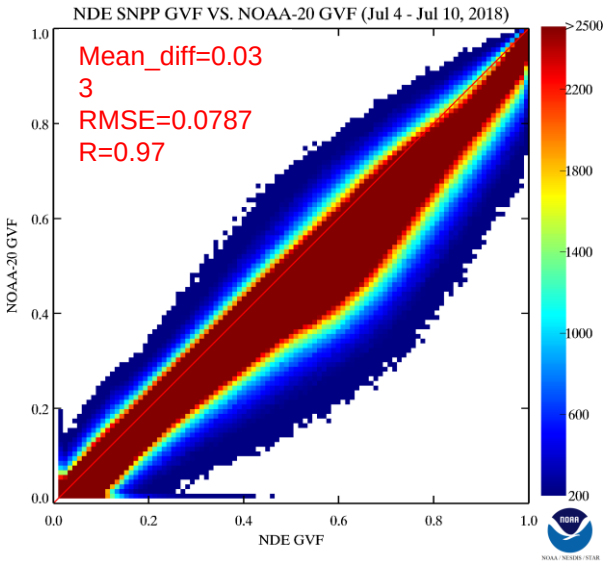


NOAA-20 GVF vs. SNPP GVF





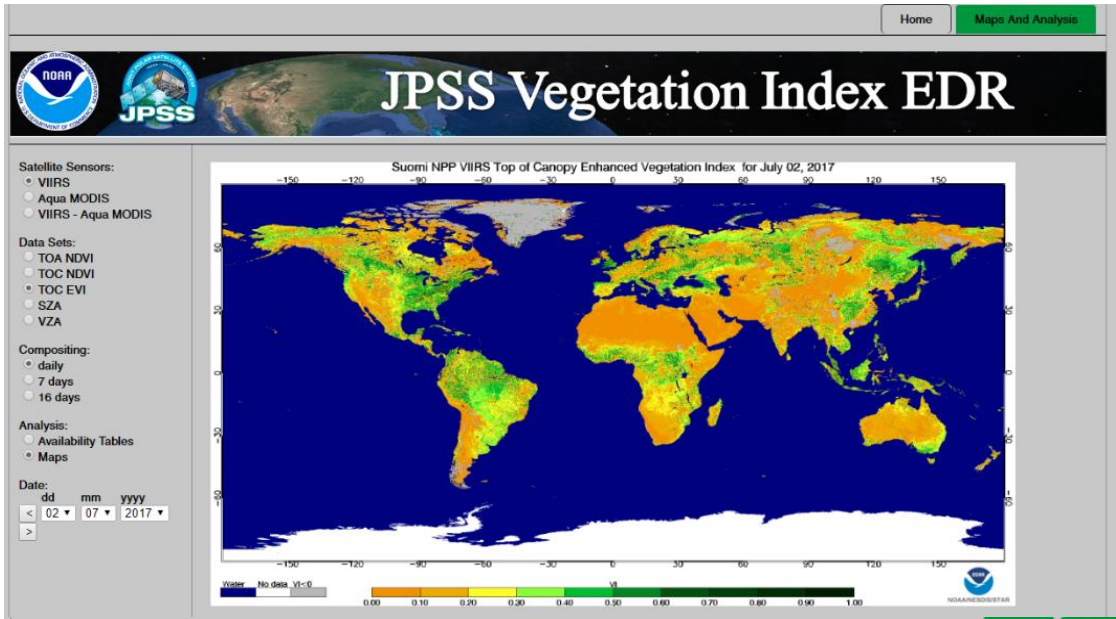




VIIRS VI Long-term Monitoring

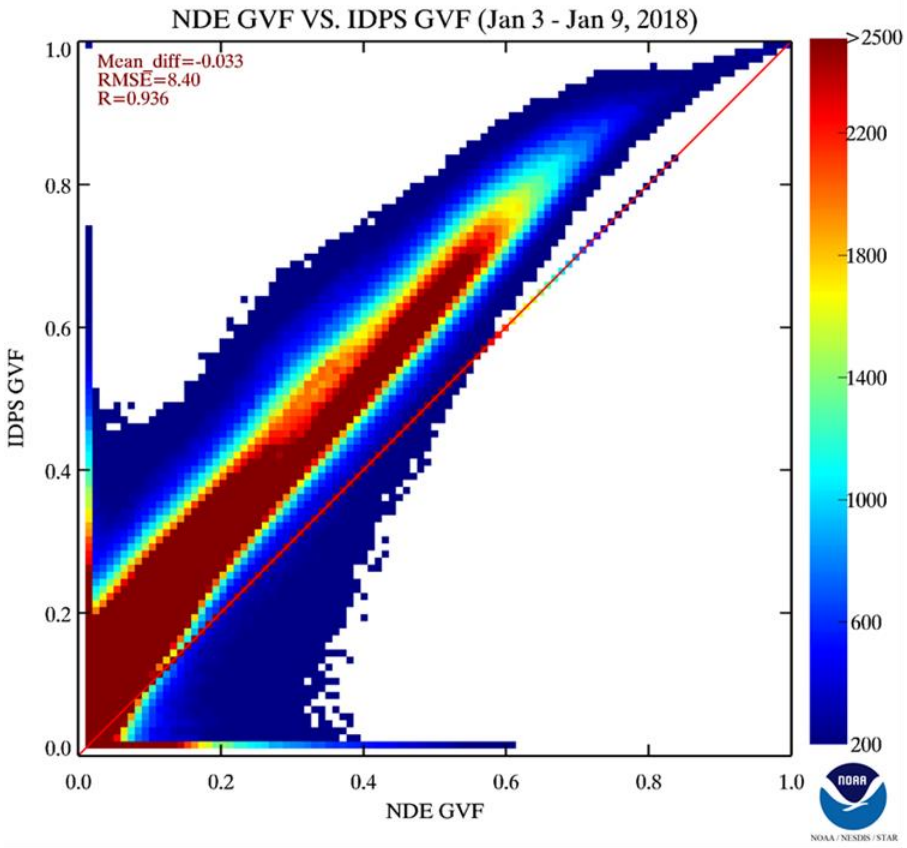
Developing a long-term monitoring tool

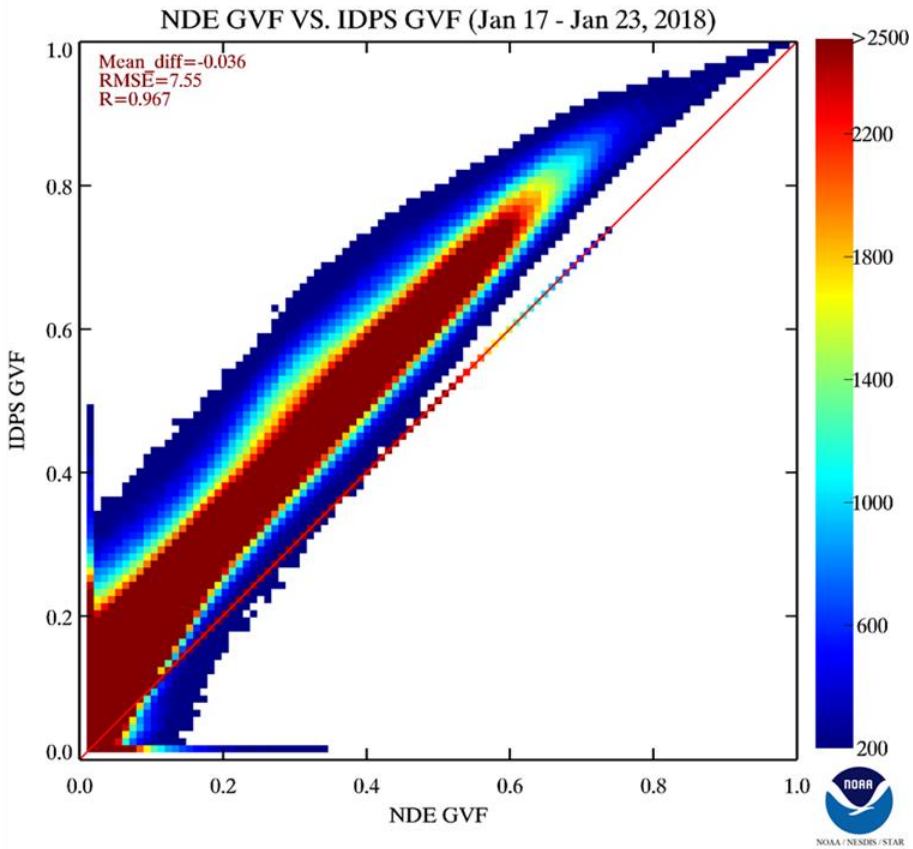
- Send alerts when abnormal results occurs;
- Automatically validate against field measurements;
- Update maps through WWW
- https://www.star.nesdis.noaa.gov/smcd/viirs_vi_web/landwatch/index.php



Issue under investigation: Input SR Diff to IDPS

GVF Comparison: NDE vs. IDPS input

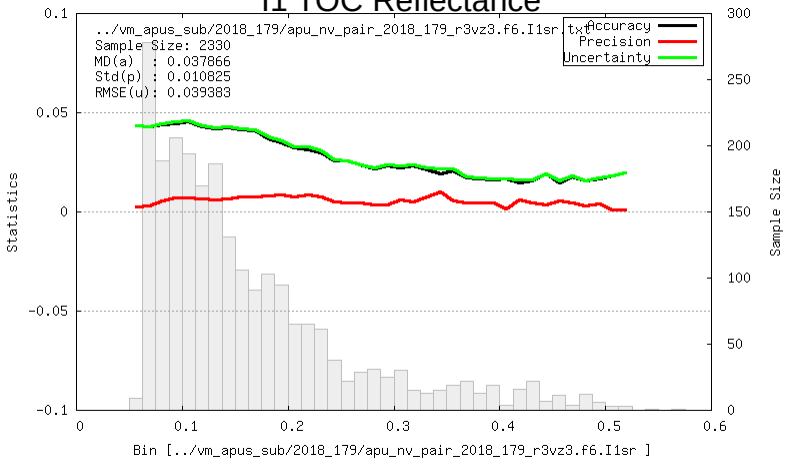




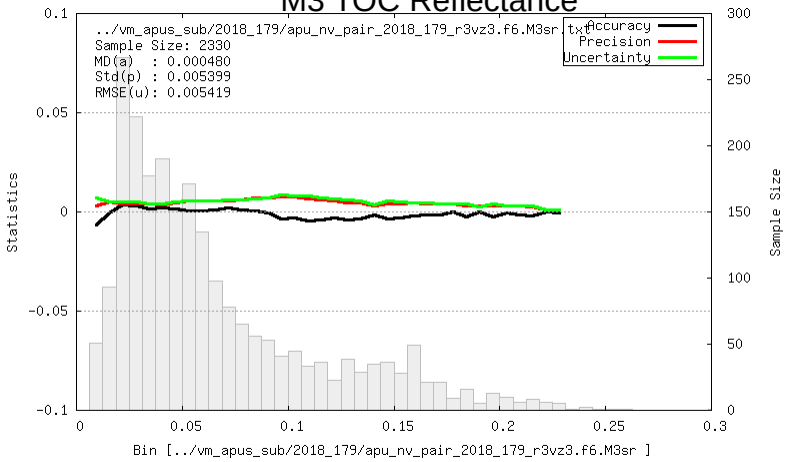
TOC Ref inconsistency

NVPS vs. IDPS: TOC Reflectance (55º – 62.5º for backward)

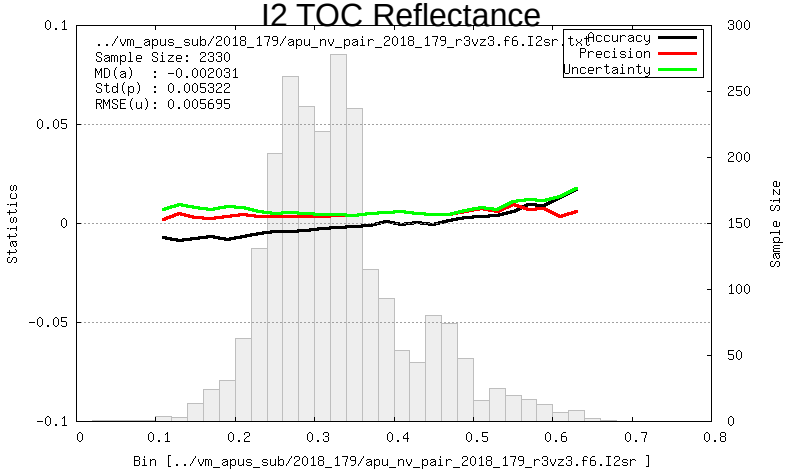
I1 TOC Reflectance



M3 TOC Reflectance

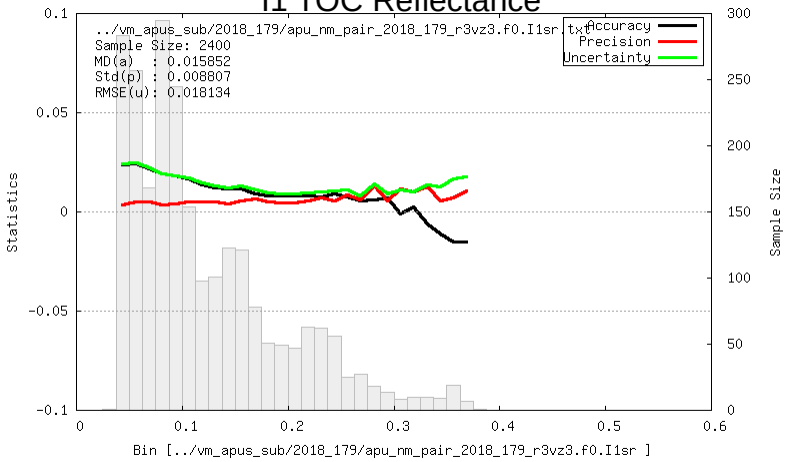


I2 TOC Reflectance

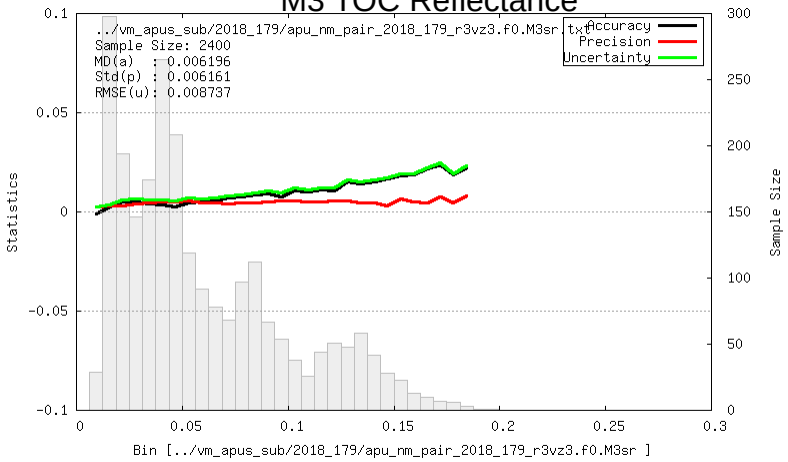


NVPS vs. MODIS: TOC Reflectance (0º – 7.5º for forward)

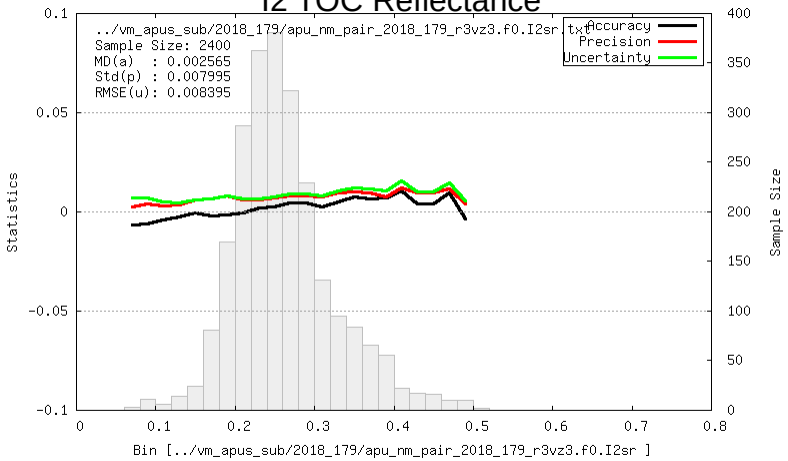
I1 TOC Reflectance



M3 TOC Reflectance

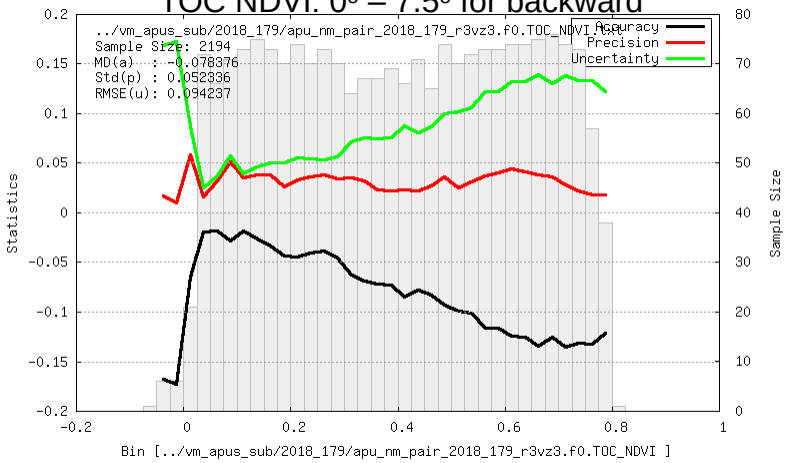


I2 TOC Reflectance

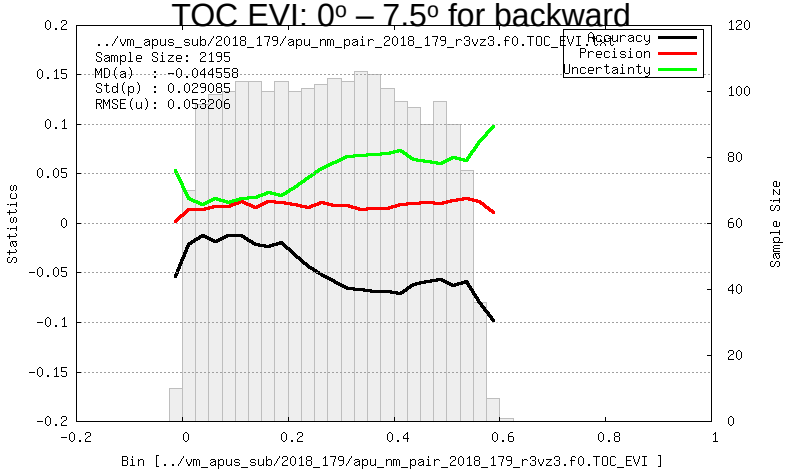


NVPS vs. MODIS

TOC NDVI: 0º – 7.5º for backward

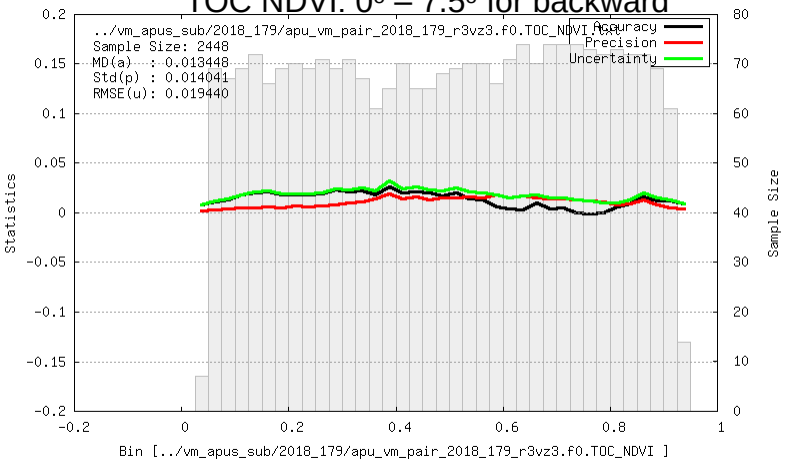


TOC EVI: 0º – 7.5º for backward

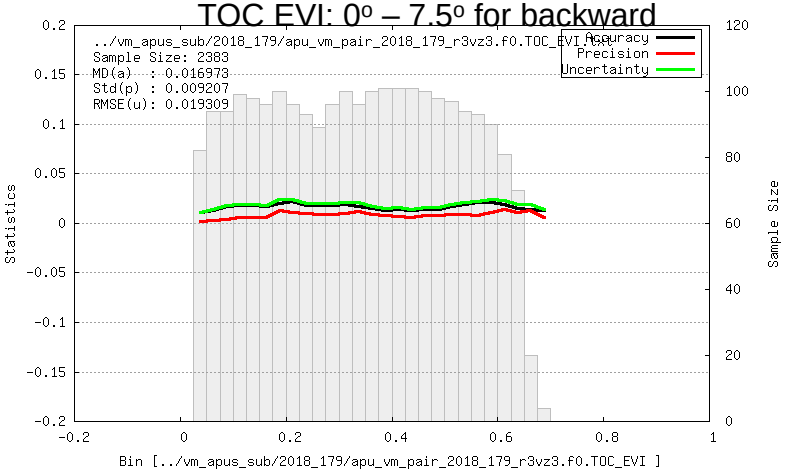


IDPS vs. MODIS

TOC NDVI: 0º – 7.5º for backward



TOC EVI: 0º – 7.5º for backward



Interactive communication with users

Current NVPS Primary Users:

- NOAA Earth System Research Lab/GSD, HRRR (Stan Benjamin)
- NCEP/EMC, Land Model (Jack Kain's group)
- NESDIS/STAR, SMOPS (Xiwu Zhan)
- NDE Downstream products VIIRS LSE/LSA

Summary

- Enterprise VI and GVF algorithms were developed and implemented for operational production on the NDE system.
- The VI and GVF data from SNPP are operational ready
- The VI and GVF data from NOAA-20 are in the NDE test environment
- Performance of the NVPS meets the requirement, though further evaluation using in-situ data is needed
- NCEP HRRR, SMOPS, and LSE are using the NVPS GVF data
- Significant VI/GVF difference observed when input data are not consistent

Path Forward

- The NVPS improvements
  - Code efficiency and robustness
  - data layer re-arrangement, redundant removal
  - QF upgrade
- Comprehensive validation will be perform using in-situ data, as well as other reference data
- Conduct provisional readiness for NOAA-20 VI and GVF production
- Significant upgrade on validation and monitoring tool is necessary
- Interactive communication with users